DEVELOPMENT OF STANDARD OPERATING GUIDELINES FOR THE UTILIZATION OF AIR-PURIFYING RESPIRATORS IN INCIDENTS INVOLVING CHEMICAL WARFARE AGENTS

EXECUTIVE DEVELOPMENT

BY: Thomas I. Herlihy
Battalion Fire Chief
District of Columbia Fire & EMS Department
Washington, DC

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ABSTRACT

Respiratory protection is considered an essential ingredient for the successful mitigation of a chemical warfare incident. The use of air-purifying respirators can provide for additional response capability in these types of events. Through the Department of Defense's Domestic Preparedness Program, the District of Columbia Fire & EMS Department received 100 air-purifying respirators for use in an incident involving chemical warfare agents. The problem was that the District of Columbia Fire Department did not have a standard operating guideline for the use of these respirators. The purpose of this research project was to develop a standard operating guideline for the use of air-purifying respirators in a chemical warfare incident. The action research method was utilized an involved and extensive review of applicable civilian regulations and standards that govern the use of air-purifying respirators. Since strict adherence to these civilian regulations would essentially prohibit the use of this type of respirator, less restrictive Army regulations were also examined in an attempt to develop a functional guideline that could be utilized in case of a full-scale emergency involving these chemical agents.

The research questions that were answered were:

1. What are the regulations and standards that govern the use of air-purifying respirators?
2. What are the United States Army's standard operating guidelines for the use of air-purifying respirators in a non-combat environment involving chemical warfare agents?

The results of the research project identified numerous regulations and standards that placed significant operational constraints on the use of these respiratory protection devices. Recommendations that were made included increased training requirements for members utilizing air-purifying respirators, increasing the Department's detection capability for chemical warfare agents, and prohibiting the use of air-purifying respirators when the chemical agent involved is a known human carcinogen. The proposed standard operating guideline is included in Appendix A.

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INTRODUCTION

Across the Nation, fire departments are attempting to raise their level of preparedness to respond to terrorist incidents. Of particular concern is the ability of the fire service to adequately respond to terrorist incidents involving chemical warfare agents. The unique challenges that these types of incidents present to the fire service was painfully demonstrated in March of 1995 when the chemical warfare agent sarin was deliberately released in the Tokyo subway system resulting in a large number of both civilian and fire fighter casualties. In order for the fire service to successfully mitigate an incident of this type, fire fighters must be equipped with personal protective equipment that protects them from these agents. A key component of the personal protective equipment necessary to protect fire fighters in incidents involving chemical warfare agents is their respiratory protection equipment. Recently, the District of Columbia Fire Department took delivery of air-purifying respirators (APRs) to be utilized for respiratory protection in long duration incidents involving chemical warfare agents. These APRs differ from the type of respiratory protection normally utilized by fire fighters and there are significant limitations to their use. The problem is that currently the District of Columbia Fire Department does not have a standard operating guideline for the utilization of these APRs. The purpose of this applied research project is to develop a standard operating guideline for the District of Columbia Fire Department to safely utilize this type of respiratory protection.

The action research method was employed in this project to answer the following research questions:

1. What are the regulations and standards that govern the use of air-purifying respirators?

2. What are the United States Army's standard operating guidelines for the use of air-purifying respirators in a non-combat environment involving chemical warfare agents?

BACKGROUND AND SIGNIFICANCE

Relatively recent events such as the bombing of the World Trade Center in New York City and the Alfred P. Murrah Federal Building in Oklahoma City demonstrated the critical rescue role that the fire service plays in responding to the aftermath of terrorist events. The recognition of this role, as well as the vulnerability of the civilian emergency response community to respond to events such as the Tokyo subway incident served as the impetus for federal legislation to assist the fire service in response preparation for these types of events. "Concerned that terrorist might move beyond using conventional weapons to weapons of mass destruction (WMD)- chemical, biological, and radiological, or nuclear devices- Congress authorized the federal government to improve capabilities to respond to such incidents, particularly at the local level"(U.S. General Accounting Office, 1998, p.1). This congressional action resulted in the Defense Against Weapons of Mass Destruction Act of 1996, commonly referred to as the Nunn-Lugar-Domenici Act. This Act, through the Department of Defense's Domestic Preparedness Program, provides training, exercises, expert advice and specialized equipment to local jurisdictions. The District of Columbia Fire Department received this much needed specialized training in January of 1998 and in November of 1998, the Department took delivery of specialized equipment to assist in responses to terrorist incidents involving

weapons of mass destruction. The equipment that the District of Columbia Fire Department received on loan from the Department of Defense consisted of decontamination equipment, detection equipment, training aides, and personal protective equipment. As specified by the Department, the personal protective equipment included 100 APRs, which consisted of the Scott AV 2000 adapter and the Scott NBC (C2A1) canister filter.

The decision to equip the Department with APRs was based on the perceived need to provide respiratory protection for an extended period of time to fire fighters involved in a large-scale chemical warfare incident. The District of Columbia Fire Department currently utilizes the Scott 4.5 Self-Contained Breathing Apparatus (SCBA) equipped with a 60-minute duration air cylinder for all operations requiring respiratory protection. While this SCBA provides excellent respiratory protection from chemical warfare agents (Department of Defense, Domestic Preparedness Program, 1998), this equipment has drawbacks. The 60-minute air supply of the SCBA significantly limits work time and the 35-pound weight of this device contributes greatly to worker fatigue. APRs provide a lesser degree of respiratory protection than SCBAs but in certain environments can provide work times considerably longer than the 60-minute duration SCBAs. Additionally, APRs are light in weight and do not contribute to worker fatigue to the same degree that SCBAs do. The advantage of longer work times and less operator fatigue is significant in view of the fact that the hazards associated with some chemical warfare agents may persist at the incident site for several hours to several weeks after these agents have been released (U.S. Army Medical Research Institute of Chemical Defense, 1995).

The Department currently does not have a specific formalized written response plan for incidents involving chemical warfare agents. Tentative response plans for a major incident of this type would involve equipping emergency personnel operating in the immediate area of such an incident with SCBAs for maximum respiratory protection. Emergency personnel operating on the periphery of such an event, and engaged in activities such as evacuations and victim decontamination, would initially utilize SCBAs for respiratory protection. Later, they could downgrade this respiratory protection to APRs at the direction of the Incident Commander.

Currently there are no standardized operating guidelines for the Incident Commander to follow in making the complex decision to downgrade respiratory protection. In the past, SCBAs have been used exclusively for respiratory protection. The utilization of APRs is a significant deviation from this practice. While SCBAs serve as an all hazard respiratory protective device, APRs are much more limited in their application. Critically important information such as the identification of the contaminant, the concentration of the contaminant, oxygen levels, airborne exposure limits, assigned protection factors, and other important facts must be known prior to placing APRs in service. The ramifications of the decision to downgrade respiratory protection are critical and have a direct impact on the safety of emergency responders. This applied research project will attempt to develop a standard operating guideline for Incident Commanders to follow in making the important decision to downgrade respirator protection. Additionally, this standard operating guideline may shape future response plans as the limitations to the utilization of these devices are more clearly defined.

The District of Columbia is not directly bound by law to follow the Occupational Safety and Health Administration (OSHA) regulations for their municipal employees. Fire department personnel are included in this exemption. However, OSHA regulations, standards promulgated by the American National Standards Institute (ANSI), as well as suggested guidelines by the National Institute of Occupational Safety and Health (NIOSH) and the American Industrial Hygiene Association (AIHA), create serious concerns of liability should the Fire Department ignore these examples of acceptable operating practices.

This research project is directly related to the material presented in the National Fire Academy's *Executive Development* course. Specifically, the development of a standard operating guideline that could improve the delivery of emergency services is related to the course content of unit 10, "Service Quality/Marketing". Also the examination of applicable regulatory requirements for the use of APRs is related to the course content of unit 11, "Legal Issues".

LITERATURE REVIEW

Research Question 1:

What are the regulations and standards that govern the use of air-purifying respirators?

OSHA has extensive regulations governing respiratory protection. These regulations can be found in the *Code of Federal Regulations* (CFR) title 29, part 1910, section 134 *Respiratory protection*. In part these regulations state "In any workplace where respirators are necessary to protect the health of the employee or whenever respirators are required by the employer, the employer shall establish and implement a written respiratory protection program with worksite-specific procedures" (29 CFR1910.134, c,1). "The employer shall select and provide an appropriate respirator based on the respiratory hazard(s) to which the worker is exposed and workplace and user factors that affect respirator performance and reliability"(29 CFR 1910.134,d, 1, i). "The employer shall identify and evaluate the respiratory hazard(s) in the workplace; this evaluation shall include a reasonable estimate of employee exposures to respiratory hazard(s) and an identification of the contaminant's chemical state and physical form"(29 CFR 1910.134, d, 1, iii).

ANSI has standards that govern the use of APRs. These standards can be found under ANSI Z88.2-1992 *American National Standard Practices for Respiratory Protection.* These standards provide a comprehensive outline of the requirements of a respiratory protection program for the use of APRs. Until recently, ANSI also had standards for the physical qualifications of the user of APRs. These standards were

found under ANSI Z88.6-1984 *American National Standard Physical Qualifications for Personal Respirator Use*. This standard has been recently withdrawn by ANSI.

The National Institute of Occupational Safety and Health (NIOSH) has regulations governing respiratory protection. These regulations can be found in the *Code of Federal Regulations* (CFR) title 42, part 84 *Approval of Respiratory Protective Devices*. These regulations address testing, certification, and fitting of respirators and their components as required under OSHA regulation 1910.134. The maximum use concentration of specific gases or vapors against which air-purifying chemical cartridges are approved for use are listed in part 84, subpart L, 84.190. NIOSH also publishes guidelines for establishing and maintaining an acceptable respiratory protection program. This OSHA recommended publication is titled *NIOSH Guide to Industrial Respiratory Protection*.

The American Industrial Hygiene Association (AIHA) publishes *Respiratory Protection A Manual and Guideline*. The primary objective of this manual is to provide practical guidance in setting up and operating respiratory protection programs that are in compliance with the regulations required under OSHA 1910.134.

While guidelines such as the *NIOSH Guide to Industrial Respiratory Protection* and the *Respiratory Protection A Manual and Guideline* from the American Industrial Hygiene Association are not enforceable as regulations, they enjoy widespread acceptance as evidenced by the following quote.

> These guidelines are written for those responsible for establishing and administering an acceptable respiratory protection program. These individuals should be knowledgeable about the basic elements of a respiratory protection program as required in the OSHA respiratory standard [29CFR1910.134] and as recommended in the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987], the *American National Standard for Respiratory Protection* (ANSI Z88.2-1992) [ANSI], and the *American Industrial Hygiene Association Respiratory Protection Manual* [AIHA 1993]"(US Dept of Health and Human Services p.3).

Research Question 2:

What are the United States Army's standard operating guidelines for the use of air-purifying respirators in a non-combat environment involving chemical warfare agents?

The United States Army's primary operational guidelines for the safe handling of chemical warfare agents are contained in two publications, *The Army Chemical Agent Safety Program* (Army Regulation 385-61) and the *Toxic Chemical Agent Safety Standards* (Army Pamphlet 385-61). These guidelines supplement each other and are designed to be used in concert. Specific chemical warfare agents are listed as well as their maximum concentrations for particular types of respiratory protection. Both these publications use tables and matrixes to simplify the presentation of data to assist in determining when it may be appropriate to use APRs in atmospheres contaminated with chemical warfare agents. Additional, Mr. Sheldon Orr, safety officer of the U.S. Army's Technical Escort Unit, provided clarification and insight into the operational aspects of the Army's guidelines for these agents. Mr. Orr was contacted about these specific Army regulations due to his position as safety officer of the Technical Escort Unit. The Technical Escort Unit is responsible for the safe transport and handling of the chemical weapons arsenal of the United States.

The fact that the U.S. Army has standard operating guidelines for the use of APRs for the handling of chemical warfare agents in non-combat situations is significant. These regulations apply to Active Army personnel as well as to civilian Army employees, civilian contractors, and Federal employees conducting work for the Army. NIOSH to date has not certified any APRs for use in atmospheres contaminated with chemical warfare agents or approved any chemical cartridge filter or canister filter for use against

specific chemical warfare agents. These items and others effectively prevent full compliance with existing requirements for the use of APRs when challenged with chemical warfare agents.

PROCEDURES

Methodology

The action research method was used to develop standard operating guidelines for the utilization of APRs in incidents involving chemical warfare agents. This procedure involved an extensive literature review of what regulations and standards exist governing the use of APRs. Commonly accepted guideline models such as those recommended by NIOSH and AIHA were also included. A literature review of the United States Army's non-combat guidelines for the use of APRs was also undertaken. While nerve, blister, blood, and choking agents all make up a category of chemicals referred to as chemical warfare agents, only the nerve and blister class of these agents would probably tax the fire service's ability to maintain respiratory protection throughout the incident. This is due to the persistency of some of these agents and the length of time these agents would remain in the area in sufficient concentrations to dictate respiratory protection. This applied research project will focus only on the two main classes of agents, nerve and blister, that represent the greatest challenge to emergency responders. The Learning Resource Center of the National Fire Academy, the Library of Congress in Washington, DC, the Government Printing Office also in Washington, DC, and the Internet served as the primary source of information for this research paper. The information on the ANSI standard Z88.2 1992 was acquired directly from ANSI due to restrictions imposed by this

standards agency on supplying libraries with current copies of this marketable standard. The Department of Defense's Domestic Preparedness Help Line (1-800-368-6498) was utilized to identify Internet address locations of non-classified Army regulations governing the handling of chemical warfare agents.

Once applicable civilian regulations and standards were identified through research question number one, they were examined in detail. This examination was undertaken to identify the components of these regulations and standards that could be successfully met when faced with the challenge of chemical warfare agents. These identified components were then incorporated into a standard operating guideline. Then the Army regulations identified in research question number two were examined in detail. These regulations were found to be less restrictive than the regulations governing the civilian handling of chemical warfare agents. The less restrictive components of the Army's regulations were then included in the standard operating guideline in those areas where compliance could not be achieved using the civilian regulations. The completed standard operating guideline then consisted of the highest level of protection achievable through regulatory efforts while still providing for a functional guideline. In reviewing this process it is important to note that the District of Columbia Fire Department already has in place a foundation of regulations and policies that govern the use of respirators that are of the SCBA type. Additional, the same respirator facepiece, which is a major component of a respiratory protection system, is utilized for both SCBA and APR operations.

Limitations

This research project was limited due to a lack of information available about the use of APRs for respiratory protection against chemical warfare agents. The author is

unaware of any other fire department that has actually equipped its members with APRs for use against these agents. Civilian regulations concerning APRs are based on non-emergency use of APRs in atmospheres that have been extensively characterized and are limited to specific contaminates. Chemical warfare agents are not specifically addressed in these regulations. The Army regulations, while useful in providing insight into how these agents are handled by the experts in this field, are not directly transferable to civilian applications. Subjective and arbitrary decisions and assumptions were necessary to formulate a functional standard operating guideline. This was necessary because of inaction by regulatory and standards agencies in issuing guidance on the emerging issue of APR use in incidents involving chemical warfare agents.

These decisions may have to be reevaluated and revised if future testing, regulation, or experience indicates a change is necessary.

Definition of Terms

Many of the following definitions were taken from the book *American National Standard Practices for Respiratory Protection* by the American National Standards Institute, the Army Pamphlet 385-61, *Toxic Chemical Agent Safety Standards,* and the book, *Respiratory Protection A Manual and Guideline* by the American Industrial Hygiene Association.

Airborne Exposure Limits (AEL). A Department of Defense term that describes the allowable concentrations in the air to which almost all unmasked chemical agent workers can be exposed to in a normal 8 hour day and 40 hour week without known adverse health effects.

Air-Purifying Respirator (APR). A respirator in which ambient air is passed through an air-purifying element that removes contaminant(s) (ANSI).

Assigned Protection Factor (APF). The expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly fitted and trained users (ANSI).

Blister Agents. A class of chemical warfare agents that injuries the eyes and lungs and burns and blisters the skin (Army Pamphlet).

Blood Agents. A class of chemical warfare agents that are absorbed by the blood stream and block the body's use of oxygen.

Canister Filter. A container with a filter, sorbent, or catalyst, or a combination of these items, which removes specific contaminants from the air passed through the container (ANSI).

Chemical Warfare Agents. Chemical compounds intended for use in military operations to kill, seriously injure, or incapacitate persons through its physiological effects (Army Pamphlet).

Choking Agents. A class of chemical warfare agents that induces acute lung injury. These agents are also referred to as pulmonary agents.

End Of Service Life Indicator (ESLI). An indicator that invokes an automatic and spontaneous warning signal when the service life has been reached (NIOSH).

Facepiece Fit Check. A test conducted by the wearer to determine if the respirator is properly seated to the face (ANSI).

IDLH (Immediately Dangerous to Life or Health. Acute respiratory exposure that poses an immediate threat of loss of life, immediate or delayed irreversible adverse

effects on health, or acute eye exposure that would prevent escape from a hazardous atmosphere (NIOSH).

Milligrams per Cubic Meter (mg/m3). A method to express the concentration of an agent as measured in milligrams per cubic meter.

Negative-Pressure Respirator. A respirator in which the air pressure inside the respiratory inlet covering is negative during inhalation with respect to the ambient air pressure (ANSI).

Nerve Agents. A class of chemical warfare agents that causes casualties by interfering with the ability of muscles to relax after stimulation by associated nerves. These agents are considered the most toxic of all the chemical warfare agents (Army Pamphlet).

Permissible Exposure Limits (PEL). Term for OSHA regulations that describe airborne exposure limits (AIHA).

Parts per Million (PPM). A method to express the concentration of an agent as measured in parts per million.

Poor Warning Properties. A substance whose odor, taste, or irritation effects are not detectable or not persistent at concentrations at or below the exposure limit (ANSI).

Quantitative Fit Test. A fit test that uses an instrument to measure the challenge agent inside and outside the respirator (ANSI).

Supplied-Air Respirator (SAR). A respirator that is equipped with a small diameter hose through which respirable air is supplied (AIHA).

Self-Contained Breathing Apparatus (SCBA). An atmosphere-supplying respirator in which the respirable gas source is designed to be carried by the wearer (ANSI).

Service Life. The period of time that a respirator provides adequate protection to the wearer (NIOSH).

RESULTS

Research Question 1:

What are the regulations and standards that govern the use of air-purifying respirators?

OSHA, ANSI, NIOSH, and AIHA have regulations and standards that require medical evaluations of employees who use APRs. This requirement is already addressed by existing Departmental regulation governing the use of SCBAs and does not require additional action for compliance.

OSHA, ANSI, NIOSH, and AIHA have regulations and standards that require that the responsibility for operating and maintaining a respirator protection program be tasked to one specific individual. This requirement is already addressed in existing Departmental regulations governing the use of SCBAs and only requires an expansion of existing duties for compliance.

OSHA, ANSI, NIOSH, and AIHA all require fit testing of respirator facepieces. The Department currently performs quantitative fit testing on all issued respirator facepieces as part of the SCBA respirator program. The same Scott AV 2000 facepiece is used for both SCBA and APR operations. No additional action is required for compliance.

OSHA, ANSI, NIOSH, and AIHA have regulations that govern the cleaning and disinfecting of respiratory facepieces. The Departments has regulations that comply with

these requirements as part of the SCBA respirator program. No additional action is required for compliance.

OSHA, ANSI, NIOSH, and AIHA all require the employer to develop and implement a written respiratory protection plan with work-site specific procedures. The development of the standard operating guideline included in Appendix A should achieve compliance in this area.

OSHA, ANSI, NIOSH, and AIHA specify that employees be trained in the specific nature of the hazards that they maybe exposed to while utilizing an APR. A training requirement on the specific hazards of chemical warfare agents is included in the proposed standard operating guideline to comply with this requirement.

OSHA, ANSI, NIOSH, and AIHA have requirements that employees be trained in the proper donning/doffing techniques of APRs as well as the limitations of respirator protection. A training requirement on the limits of protection afforded by the Department's APRs against chemical warfare agents as well as proper donning/doffing techniques is included in the proposed standard operating guideline to comply with this requirement.

OSHA, ANSI, NIOSH, and AIHA have regulations and standards that specify that if a contaminant can not be identified and quantified, the atmosphere shall be assumed to be IDLH and the use of APRs is prohibited. This requirement is incorporated in the proposed standard operating guideline to achieve compliance in this area.

OSHA, ANSI, NIOSH, and AIHA have regulations that specify that APRs shall not be utilized in oxygen deficient atmospheres. A requirement that APRs not be utilized in

oxygen deficient atmospheres is incorporated into the proposed standard operating guideline to achieve compliance in this area.

OSHA, ANSI, NIOSH, and AIHA require that SCBAs be utilized in IDLH atmospheres. This requirement effectively eliminates the use of APRs in these situations. This requirement is incorporated in the proposed standard operating guideline to achieve compliance in this area.

OSHA, ANSI, NIOSH, and AIHA prohibit the use of both SCBA and APR respirators by personnel that have facial hair that could interfere with the facepiece seal of the respirator. The Department does not adhere to this requirement for members utilizing positive pressure SCBA facepieces. APRs have facepieces that are operated in the negative pressure mode and they are inherently more susceptible to facepiece leaks. A requirement in the proposed standard operating guideline prohibits members from using APRs if they have facial hair, which may interfere with the facepiece seal. This requirement will achieve compliance in this area.

OSHA, ANSI, and NIOSH have requirements that the user perform a negative-pressure facepiece fit test each time an APR is worn. This self-test is to be performed prior to entering the contaminated area. This requirement is incorporated in the proposed standard operating guideline to achieve compliance in this area.

OSHA, ANSI, NIOSH, and ANSI have storage requirements to protect APRs and their cartridges/canisters while they are not in use. A requirement in the proposed standard operating guideline is included to comply with this requirement.

NIOSH has a recommendation that specifies that if a contaminant is identified as a potential human carcinogen, only a SCBA or a SAR maybe used to provide respiratory

protection. Army Regulation 385-61 also specifies this restriction. Mustard agents H, HD, HN, and HT as well as Lewisite are chemical warfare agents that are known human carcinogens. A requirement prohibiting the use of APRs in incidents involving these blister agents is included in the proposed standard operating guideline to comply with these requirements.

Research Question 2:

What are the United States Army's standard operating guidelines for the use of air-purifying respirators in a non-combat environment involving chemical warfare agents?

NIOSH recommends that when respiratory protection is required under emergency conditions, only SCBA respiratory protection be worn. Compliance with this recommendation would prevent the use of APRs in terrorist incidents involving chemical warfare agents. Army Regulation 385-61 and Army Pamphlet 385-61 specify that APRs can be used in emergency incidents. This less restrictive Army regulation was used as a supportive basis for allowing APR use in emergency incidents in the proposed standard operating guideline.

OSHA, ANSI, and AIHA require and recommend that APR canister filters have an end-of-service-life-indicator (ESLI) or change schedule based on data that will ensure canisters are changed before the end of their service life. Since there are no approved chemical warfare agent canister filters, data recommending service life is not available. The Scott AV 2000 APR utilizes the C2A1 military canister filter. Both Army Regulation 385-61 and Army Pamphlet 385-61 specify that these military canister filters be changed every two hours when they are exposed to contaminant levels above AEL

levels. This Army requirement served as a basis to specify a two-hour change schedule in the proposed standard operating guideline.

ANSI, NIOSH, and AIHA recommend that APRs not be utilized when contaminants have poor warning properties above PEL/AEL levels. Many chemical warfare agents such as sarin (GB), VX, and tabun (GA) have poor warning properties at AEL levels and adherence to the recommendations would prevent the use of APRs in incidents involving many of the chemical warfare agents. Army Regulation 385-61 and Army Pamphlet 385-61 permit the use of APRs in incidents involving non-carcinogenic chemical warfare agents. The guidance provided by these Army regulations serves as the basis for incorporating APR use in the proposed standard operating guideline.

OSHA, ANSI, NIOSH, and AIHA specify that a NIOSH approved respirator be utilized. NIOSH has not approved any APRs for use against chemical warfare agents. Compliance with this regulation and recommendation would prevent the use of APRs in chemical warfare incidents. Army Regulation 385-61 and Army Pamphlet 385-61 state that specific military APRs or those certified by the military as equivalent maybe worn in incidents involving some chemical warfare agents. The Scott AV 2000 APR that is utilized by the District of Columbia Fire Department is not approved by the military. The Scott C2A1 canister filter, which is a major component of this APR, is approved by the military. In fact, several of the approved military APRs utilize this same canister filter. The use of non-NIOSH approved APRs in the proposed standard operating guideline was based on the Army's deviation from this requirement as well as the similarities of the major components of the military approved APRs and those supplied to the District of Columbia Fire Department.

Army Regulation 385-61 and Army Pamphlet 385-61 assign a protection factor of 2000 to military APRs. NIOSH assigns a protection factor of 50 to full facepiece negative pressure APRs while ANSI attributes a protection factor of 100 to this class of respiratory protection. A protection factor of 50, which is consistent with the NIOSH standard, was arbitrarily assigned to this APR assembly for the purpose of determining operational guidelines. This protection factor is subject to revision if additional information becomes available to provide guidance in this area.

Army Regulation 385-61 and Army Pamphlet 385-61 require that continuous real-time monitoring with an alarm set at the applicable IDLH value be utilized when APRs are placed in service. The District of Columbia Fire Department does not have such sophisticated equipment. Compliance with this requirement will be attempted by requiring frequent air sampling in areas that APRs are being utilized in, with an additional requirement that continuous real-time monitoring with an alarm be deployed when this equipment becomes available from responding Federal or military assets.

DISCUSSION

The results of this applied research project showed that there are significant restrictions on the use of APRs as well as serious limitations on their ability to provide adequate respiratory protection. These restrictions and limitations must be fully known and followed by Incident Commanders to ensure the safety of emergency responders in incidents involving chemical warfare agents.

The respiratory system is susceptible to more injury from hazardous material situations than any other body system except the skin. Selecting the proper respiratory protection

equipment, and using it correctly for emergency control, escape from life-threatening situations, or routine work is as critical as choosing protective apparel for the skin. Using the wrong respirator puts the wearer at risk of injury or death (Phillips &Browner, 1994, p.37).

There is presently an unmet need for guidance for the use of APRs in incidents involving chemical warfare agents. This is characterized by the following quote.

OSHA recognizes that there are unique contaminate situations, such as those involving chemical warfare agents, that involve primarily military exposure and that may require specialized respiratory protection equipment. Niosh certification for respiratory protection specific to such hazards does not exist and is not likely to be forthcoming (Federal Register, 1998, p.1197).

With the current threat level of terrorist activity in the United States, it is important that the emergency response community have a baseline response to all types of terrorist threats. "As the NBC [Nuclear, Biological, Chemical] weapons become more available, as the technology of science improves, and as more information becomes more readily available, the when becomes more assured of occurring on the time line. 'When' will happen. Of that there is no question"(Mullins, 1997,p.356). Special Agent Jim Rice, the FBI agent who supervises the agency's terrorism task force was recently quoted as saying, 'We always take the stand that Washington is the number one target in the world and go from there" (Fernandez, Horwitz, 1999,April 14).

Given the unique threat facing the Nation's Capital, it is imperative that the District of Columbia Fire Department has a baseline response to incidents involving chemical warfare agents. Guidelines that allow for the safe use of APRs by emergency responders provides the District of Columbia Fire Department with an additional capability to address such an event. The limitations and restrictions of these devices that surfaced during this research process serve to more clearly define the parameters of their potential deployment options. This information will assist the Incident Commander in the possible

deployment of members equipped with this type of respiratory protection and will provide guidance in the preparation of a standard operating guideline for an overall response plan to this type of incident.

RECOMMENDATIONS

This applied research project identified numerous training issues that must be addressed prior to the District of Columbia having a fully functional APR capability. Personnel must be trained in the unique hazards of chemical warfare agents as well as the signs and symptoms of exposure to these agents. The limitations of APRs compared to SCBAs must be fully known by members wearing this protective equipment. Practical training sessions that cover actual donning and doffing techniques, negative pressure self-tests, canister filter replacement schedules, and actual familiarization time with this new equipment must be provided for by the Department. The proper storage of this equipment, specifically the APR canister filter, needs to be included in the training program. The Department must train Incident Commanders in the use and limitations of APRs because the decision to employ APRs for respirator protection ultimately rests with the Incident Commander.

It is recommended that the Department reevaluate their hazardous material detection equipment for chemical warfare agents. Currently the Department is equipped with the Chemical Agent Monitor (CAM), the Saw Minicad Mk ll detector, Draeger Tubes, M256A1 Chemical Agent Detector Kits, M-8 paper, and photo ionization detectors. However, APR use is dependent on knowing the identity of the contaminate as well as

the concentration. Detection equipment that only identifies the product but does not quantify the concentration at very low levels has only limited value in determining if it is safe for APRs to be utilized.

The focus of this applied research project was very narrow. Only the nerve and blister classes of chemical warfare agents were examined. The threat of terrorism also includes the possibility of nuclear and biological weapons. APRs may have a role in these types of events. It is recommended that these types of incidents be examined and if APRs provide the response community with additional capability in these areas, then guidelines should be developed and incorporated into the proposed standard operating guideline.

It is recommended that the regulations and standards that govern the use of APRs be closely monitored for changes that may affect the response community. With the threat of terrorism growing in this country, changes and clarification in these regulations maybe forthcoming. Standard operating guidelines may have to be updated to reflect more relaxed or stringent requirements for APR use. New APR products from equipment manufacturers should also be followed closely as manufacturers may attempt to address some of the shortfalls of the present equipment as the demand for this type of equipment increases.

Finally, regulations and standards can vary from state to state. The District of Columbia is not covered by a State OSHA plan. Federal OSHA regulations therefore do not apply directly to District of Columbia municipal employees. Additional, Washington DC is a Federal city which makes it unique in many regulatory areas. It is recommend

that readers who refer to the proposed standard operating guideline for guidance realize that different regulations may apply in their jurisdictions.

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APPENDIX A

Proposed Standard Operating Guidelines For The Utilization of Air-Purifying Respirators In Incidents Involving Chemical Warfare Agents

Policy

APRs shall be used for respiratory protection only when specifically authorized by the Incident Commander. Incident Commanders should authorize the use of APRs only in emergency situations such as full-scale chemical warfare incidents that overwhelm the Department's ability to maintain respiratory protection through the use of SCBAs. Members dependent on APRs for respiratory protection may not be deployed into the hot zone of these hazardous material incidents. Members relying on APRs for respiratory protection who are deployed into the warm zone should have additional limitations placed on their activities to minimize their potential exposure to toxic contaminants. Incident Commanders should be fully aware of the significant protection limitations of APRs. The authorization to permit APR use should only be issued after a complete site characterization by the Hazardous Material Unit or other competent authority. All aspects of the standard operating guideline must be followed to insure adequate protection from these chemical agents.

These guidelines for the use of APRs are in addition to the Department's regulations governing training requirements, medical examinations, cleaning and disinfecting procedures, fit testing, program administration and other pertinent components of our existing SCBA respiratory protection program.

Restrictions/Limitations

The identification and quantification of chemical warfare agents is limited by the DC Fire Department's current detection capability. Assistance in the identification and quantification of the chemical warfare agent involved will have to be received from Federal or military sources such as the Army's Technical Escort Unit, to safely utilize APRs. Once identified and quantified, the DC Fire Department has detection equipment sensitive enough to monitor the incident site for the safe use of APRs in incidents involving the nerve agents tabun (GA) and sarin (GB). Assistance with identification, quantification as well as monitoring will have to be received from specialized Federal/military sources in order to safely utilize APRs in incidents involving the nerve agents soman (GD) and VX.

The following restrictions and limitations apply to APR use in chemical warfare incidents:

- Only members fully trained in all aspects of APRs may use this type of respiratory protection.
- APRs may not be used for protection against mustard agents (H, HD, HN, and HT) or Lewisite (L). These agents are known carcinogens.
- If a chemical warfare agent contaminant cannot be identified and quantified, APR use is prohibited.
- If oxygen levels are less than 19.5%, APRs cannot be utilized.
- APR use is not permitted in IDLH atmospheres
- Members who have facial hair that may interfere with the facepiece seal shall not be permitted to use APRs.

- Canister filters shall be stored in their sealed container in an upright position. Canister filters found in open containers shall be not be used.

Procedure

- Only the Scott AV-2000 facepiece and the Scott AV-2000 adapter with the C2A1 canister filter is to be used for APR protection from chemical warfare agents.
- A negative pressure facepiece fit check must be performed each time the APR is worn.
- Air monitoring in the warm zone shall be done at frequent intervals using DC Fire Department detection devices. Continuous real-time monitoring shall be implemented when Federal or military support provides us with this capability.
- When air monitoring indicates that the contaminant level has exceeded the maximum exposure concentration, members shall leave the contaminated area at once.
- Canister filters shall be changed after a maximum of two hours of use in atmospheres with contaminant levels above AEL levels.
- DC Fire Department's current monitoring capability limits the use of APRs to incidents involving the nerve agents tabun (GA) and sarin (GB).
- APRs maybe used for respiratory protection from the nerve agents VX and soman (GD) if assistance with identification, quantification and monitoring is obtained from sources such as the Federal government, military units, or other specialized resources.
- An Assigned Protection Factor (APR) of 50 shall be utilized in determining the operational limitations of the APR.
- The maximum exposure concentration for APR use shall be determined by the

following formula:

(AEL) X (APF) = Maximum Exposure Concentration

Table 1

Maximum Chemical Exposure Concentrations For APR Use Measured In mg/m3

Chemical Warfare Agent Name	Airborne Exposure Limit (AEL) mg/m3	IDLH mg/m3	APR Assigned Protection Factor (APF) =50	Maximum Exposure Concentration With APR mg/m3
GA Tabun	.0001	.2	50	.005
GB Sarin	.0001	.2	50	.005
GD Soman	.00003	.06	50	.0015
VX	.00001	.02	50	.0005

Table 2

Maximum Chemical Exposure Concentrations For APR Use Measured In ppm

Chemical Warfare Agent Name	Airborne Exposure Limit (AEL) ppm	IDLH ppm	APR Assigned Protection Factor (APF) =50	Maximum Exposure Concentration With APR ppm
GA Tabun	.000015	.03	50	.00075
GB Sarin	.000017	.03	50	.00085
GD Soman	.000004	.008	50	.0002
VX	.0000009	.0005	50	.000045

The Scott C2A1 canister filter also meets the military specifications for protection against cyanogen chloride, hydrogen cyanide, phosgene, and the riot control agents CS and CN. However, it is not anticipated that downgrading respirator protection from SCBAs to APRs would become necessary in incidents involving these agents.